Patent claims

1. (currently amended) Electric camshaft adjuster for adjusting and securing the phase angle of a camshaft of an internal combustion engine with respect to ~~its~~ a crankshaft, comprising:

- ~~having~~ a drive wheel ~~(1)~~ which is connected fixedly in terms of rotation to the crankshaft,
- an output component ~~(4)~~ which is fixed to the camshaft, and
- a harmonic drive
- having at least one ring gear-spur gear pairing,
- one of the two components being connected fixedly in terms of rotation to the drive wheel ~~(1)~~, and the other component having at least a torque-transmitting connection to the output component ~~(4)~~,
- the spur gear being embodied as a flexurally elastic sleeve ~~(18)~~ and
- being arranged at least partially within the first ring gear ~~(2, 5)~~,
- ~~having~~ a wave generator ~~(17, 17′, 17″)~~ which is driven by an electric adjustment motor by means of an adjustment shaft ~~(10, 10′, 10″, 10‴)~~ which is fixed to the gearing,
- ~~which~~ the wave generator ~~(17, 17′, 17″)~~ has means for elliptically deforming the flexurally elastic sleeve ~~(18)~~,
- ~~as a result of which~~ the sleeve ~~(18)~~ is deformed in such a way that a torque-transmitting connection is formed between the ring gear ~~(2, 5)~~ and the sleeve ~~(18)~~ at two points on the sleeve ~~(18)~~ lying opposite one another, ~~characterized in that~~

  whererin at least one of the gears of the ring gear-spur gear pairing is formed in one piece with the drive wheel ~~(1)~~ or output component ~~(4)~~.

2. (currently amended) Electric camshaft adjuster for adjusting and securing the phase angle of a camshaft of an internal combustion engine with respect to ~~its~~ a crankshaft, comprising:

- ~~having~~ a drive wheel ~~(1)~~ which is connected fixedly in terms of rotation to the crankshaft,
- an output component ~~(4)~~ which is fixed to the camshaft, and
- a harmonic drive
- ~~having~~ at least one ring gear-spur gear pairing,
- one of the two components being connected fixedly in terms of rotation to the drive wheel ~~(1)~~, and the other component having at least a torque-transmitting connection to the output component ~~(4)~~,
- the spur gear being embodied as a flexurally elastic sleeve ~~(18)~~ and
- being arranged at least partially within the first ring gear ~~(2, 5)~~,
- ~~having~~ a wave generator ~~(17'')~~ which is driven by an electric adjustment motor by means of an adjustment shaft ~~(10'', 10''')~~ which is fixed to the gearing,
- ~~which~~ the wave generator ~~(17'')~~ has means for elliptically deforming the flexurally elastic sleeve ~~(18)~~,
- ~~as a result of which~~ the sleeve ~~(18)~~ is deformed in such a way that a torque-transmitting connection is formed between the ring gear ~~(2, 5)~~ and the sleeve ~~(18)~~ at two points on the sleeve ~~(18)~~ lying opposite one another, ~~characterized in that~~
- wherein the means for elliptically deforming the flexurally elastic sleeve ~~(18)~~ are two bearing journals ~~(29)~~ which are attached to the adjustment shaft ~~(10'', 10''')~~ and bear against two regions of the sleeve ~~(18)~~ lying opposite one another, a roller bearing ~~(13''')~~ being arranged on each of said bearing journals ~~(29)~~.

3. (currently amended) Camshaft adjuster according to one of Claims 1 or 2, ~~characterized in that~~ wherein the sleeve ~~(18)~~ is of pot-shaped design.

4. (currently amended) Camshaft adjuster according to one of Claims 1 or 2, ~~characterized in that~~ wherein a second ring gear ~~(5)~~ is arranged in the axial direction next to the first ring gear ~~(2)~~ and coaxially with respect thereto, the sleeve ~~(18)~~ is arranged at least partially within the second ring gear ~~(5)~~ and enters into a torque-transmitting connection with the second ring gear ~~(5)~~ at two points lying opposite one another.

5. (currently amended) Camshaft adjuster according to one of Claims 1 or 2, ~~characterized in that~~ wherein the torque-transmitting connection between the ring gear ~~(2, 5)~~ and the sleeve ~~(18)~~ is implemented by means of an external toothing ~~(28)~~ of the sleeve ~~(18)~~ which engages in an internal toothing ~~(3, 6)~~ of the ring gear ~~(2, 5)~~, and the number of teeth of the internal toothing ~~(3, 6)~~ of the ring gear ~~(2, 5)~~ differs from the number of teeth of the external toothing ~~(28)~~ of the sleeve ~~(18)~~.

6. (currently amended) Camshaft adjuster according to one of Claims 1 or 2, ~~characterized in that~~ wherein the torque-transmitting connection between the ring gear ~~(2, 5)~~ and the sleeve ~~(18)~~ is implemented in a frictionally locking fashion by means of the interaction of the smooth internal lateral face of the ring gear ~~(2, 5)~~ and the smooth external lateral face of the sleeve ~~(18)~~.

7. (currently amended) Camshaft adjuster according to one of Claims 1 or 2, ~~characterized in that~~ wherein the electric adjustment motor is preferably embodied as a brushless DC motor (BLDC motor) which is operated in bipolar fashion and has a

stator fixed to the cylinder head and preferably a rare earth magnet.

8. (currently amended) Camshaft adjuster according to one of Claims 1 or 2, ~~characterized in that~~ wherein the motor shaft of the BLDC motor and the adjustment shaft ~~(10, 10', 10'', 10''')~~ have a connection by means of a rotationally fixed but radially movable or resilient coupling, which is preferably embodied as a polymer coupling ~~(26)~~.

9. (currently amendment) Camshaft adjuster according to one of Claims 1 or 2, ~~characterized in that~~ wherein a stop ring ~~(22)~~ is attached to the drive wheel ~~(1)~~ and has a lug ~~(8)~~ which engages in a corresponding, annular-segment-shaped cut-out ~~(9)~~, which limits the adjustment angle, of the output component ~~(4)~~.

10. (currently amended) Camshaft adjuster according to one of Claims 1 or 2, ~~characterized in that~~ wherein a securing ring ~~(20)~~ whose external diameter corresponds at least to the tooth head diameter of the first ring gear ~~(2)~~ can be pressed into the latter.

11. (currently amended) Camshaft adjuster according to one of Claims 1 or 2, ~~characterized in that~~ wherein at least the adjustment shaft ~~(10, 10', 10'', 10''')~~ can have cut-outs for the purpose of reducing the weight and/or can be composed of lightweight metal, plastic or a composite material.

12. (currently amended) Camshaft adjuster according to one of Claims 1 or 2, ~~characterized in that~~ wherein at least one of the toothing components ~~(3, 6, 28)~~ is composed of lightweight metal, plastic or a composite material in order to reduce the weight.

13. (currently amended) Camshaft adjuster according to one of Claims 1 or 2, ~~characterized in that~~ wherein all the components or individual components, preferably the toothing components ~~(3, 6, 28)~~, of the harmonic drive ~~(19, 19')~~ are fabricated in a non-material-removing fashion.

14. (currently amended) Camshaft adjuster according to Claim 5, ~~characterized in that~~ wherein the components of the harmonic drive ~~(19, 19')~~ are fabricated in a non-material-removing fashion, and the toothings ~~(3, 6, 28)~~ are subsequently hardened or nitrated.

15. (currently amended) Camshaft adjuster according to Claim 1, ~~characterized in that~~ wherein the means for elliptically deforming the flexurally elastic sleeve ~~(18)~~ is a wave ring ~~(11, 11')~~ with an elliptical external circumference ~~(12)~~ and an elliptically deformed roller bearing ~~(13, 13', 13'')~~ attached thereto.

16. (currently amended) Camshaft adjuster according to Claim 5, ~~characterized in that~~ wherein the means for elliptically deforming the flexurally elastic sleeve ~~(18)~~ is a wave ring ~~(11, 11')~~ with an elliptical external circumference ~~(12)~~ and an elliptically deformed roller bearing ~~(13', 13'')~~ attached thereto, and the external ring ~~(15'')~~ of the roller bearing ~~(13', 13'')~~ and the externally toothed sleeve ~~(18)~~ are embodied in one piece.

17. (currently amended) Camshaft adjuster according to Claim 15, ~~characterized in that~~ wherein the elliptical wave ring ~~(11')~~ and the internal ring ~~(14')~~ of the roller bearing ~~(13'')~~ are embodied in one piece.

18. (currently amended) Camshaft adjuster according to Claim 2, ~~characterized in that~~ wherein the bearing journals ~~(29')~~ are rotatably attached to the adjustment shaft ~~(10''')~~ using an eccentric fastening means and can be secured in any desired rotational angle position.

19. (currently amended) Camshaft adjuster according to Claim 2, ~~characterized in that~~ wherein the roller bearings ~~(13''')~~ have eccentrically formed internal rings ~~(25)~~ which can be pressed onto the bearing journals ~~(29)~~ in any desired rotational angle position.

20. (currently amended) Camshaft adjuster according to one of Claims 1 or 2, ~~characterized in that~~ wherein all or some of the camshaft adjuster components are manufactured by means of stamped packetization.